



**CALIFORNIA  
ENERGY COMMISSION**



**CALIFORNIA  
NATURAL  
RESOURCES  
AGENCY**

California Energy Commission  
Clean Transportation Program

## **FINAL PROJECT REPORT**

# **Hydrogen Readiness in Early Market Communities**

**Prepared for: California Energy Commission**

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# California Energy Commission

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## **DISCLAIMER**

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## **ACKNOWLEDGEMENTS**

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# **PREFACE**

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the CEC to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to \$20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about \$100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-13-603 to provide funding for the Hydrogen Readiness in Early Market Communities Program. In response to PON-13-603, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards December 16, 2013, and the agreement was executed as ARV-13-056 on October 30, 2014.

# ABSTRACT

Hydrogen Readiness in Early Market Communities is intended to address the challenges of building hydrogen stations at a time that the technology is new and to define specific actions that communities and regions can take to introduce fuel cell electric vehicles as a zero-emission transportation choice. Addressing information gaps related to the planning and permitting of hydrogen stations, and in education and knowledge of fuel cell electric vehicles will encourage the purchase and use of these vehicles, resulting in decreased greenhouse gas emissions and air pollutants.

**Keywords:** California Energy Commission, hydrogen fueling station, fuel cell electric vehicles (FCEV), zero emission vehicles (ZEV), renewable hydrogen

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# EXECUTIVE SUMMARY

California's Advanced Clean Cars program requires automakers to place increasing numbers of zero emission vehicles into service each year. By 2050, the California Air Resources Board projects that 87 percent of light-duty vehicles on the road will be zero emission battery and fuel cell vehicles, with fuel cell electric becoming the dominate powertrain.

Through the Clean Transportation Program, the California Energy Commission provides capital expense and operating and maintenance funding to build and commission hydrogen fueling stations. In 2014 and 2015, station developers began the building several stations at a time instead of building stations one by one. It is vital to address challenges in financing, planning, and permitting stations, and to build awareness of hydrogen and fuel cells at this point in early commercialization.

With funding from the California Energy Commission, the Hydrogen Readiness in Early Markets study was led by the South Coast Air Quality Management District with BKi—the consulting firm that staffs the California Fuel Cell Partnership—and Energy Independence Now as contributors. The study team examined the status of fuel cell electric vehicles and hydrogen fueling stations in California as these technologies make their commercial debut, taking into account the prospects and challenges of increasing renewable hydrogen production; planning, permitting, and building hydrogen stations; fire and safety training; and marketplace acceptance.

It is important to note that just a few years ago, most hydrogen stations were behind-the-fence, private use stations and automakers had a limited number of cars in demonstration programs. At the writing of this report, 20 retail hydrogen stations are open, and more are in phases of planning and construction. Three automakers have fuel cell electric vehicles available for sale or lease, and more are announced. Industry and government focus are on accelerating this growth, this report provides recommendations and best practices, which incorporate significant input from industry stakeholders and from the public in the matter of marketplace acceptance.

The findings show that hydrogen readiness is an intensive, multi-faceted undertaking that can ultimately sustain itself as more vehicles and stations become available throughout the state. Cities and regions can take specific actions now that encourage fleets and end customers to drive zero-emission vehicles.

Throughout the performance period of this project, the project partners worked actively with the communities named in the proposal:

- Berkeley
- South San Francisco
- Santa Monica and West Los Angeles
- Sacramento
- Long Beach
- San Diego
- Torrance and nearby coastal communities

- Irvine and Southern Orange County
- Central Valley (e.g. Bakersfield, Fresno)

As this final report is being written, six of the cities—Sacramento, South San Francisco, Santa Monica/West Los Angeles, Long Beach, Torrance, and Irvine—have their first retail hydrogen station and are planning for their second (and some are planning a third.) A station is under construction in the San Diego area.

To spur consideration of the activities in this report, South Coast Air Quality Management Department and BKi will actively disseminate this plan and present its key findings to cities and regions throughout California to extend the reach of the program.

# CHAPTER 1:

## Introduction

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According to the *Joint Agency Staff Report on Assembly Bill 8: Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*, about 50 hydrogen stations (including a mobile refueler) will be open in 2016. The report also states, “According to the air resource board (ARB) survey of FCEV automakers, 10,500 FCEVs are projected in California by the end of 2018, and 34,300 by the end of 2021.”

Nearly all of the hydrogen stations open, in construction, or being upgraded are hydrogen storage and dispensing equipment added to an existing retail gasoline station.<sup>6</sup> Building a station requires partnership between the hydrogen station developer, the owner of the gas station, local government, and state government. It also requires that FCEVs are deployed near the station to create a demand for fuel.

When the project partners south coast air quality management department (SCAQMD), BKI Transportation<sup>1</sup>, and Energy Independence Now<sup>2</sup> submitted their proposal for this project in September 2013, three outcomes were anticipated as a result of the project tasks:

- Traditional fuel retailers, wholesalers, and distributors would see a clear business case for (1) adding hydrogen to their existing business models, or (2) creating an entirely new business around hydrogen.
- In early-market communities, the time to contract, permit, and build a hydrogen station would be comparable to other commercial building processes. Building and fire inspectors would know to use the ZEV Guidebook published by the Office of the Governor and would have easy access to local resources as well.
- Public and private fleet managers would have a clear path to purchasing or leasing FCEVs to replace less-efficient, higher-polluting sedans and sport utility vehicles. The path would include access to hydrogen fuel at public hydrogen stations and would be similar to how many fleets fuel vehicles with gasoline and diesel today.
- With the project’s conclusion in June 2016, outcomes are slightly different than expected:
- The traditional fueling industry does not yet see a clear business case for hydrogen; however, industry stakeholders are much more receptive to it. The CEC’s first two program opportunity notices for capital cost funding for hydrogen were under-subscribed. The 2013 notices were over-subscribed. As we wrap up this project, 2016 notices are available, and we anticipate even more very well-qualified proposals.
- The time to contract, plan, permit, and construct hydrogen stations has decreased from
- 4.9 years in 2009 to 1.6 years in 2013. The planning and permitting steps are approaching the same time frame as a gasoline station.
- Fleet managers have a path to purchase fuel cell electric vehicles through the State of California purchasing agreement. Many, however, have a difficult time justifying the price of a “luxury” car, cannot use a tax credit incentive, and can’t include free fuel in their purchase

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<sup>1</sup> [BKI Transportation website](https://prezi.com/nker_pzc8v0k/bki-transportation/) [https://prezi.com/nker\\_pzc8v0k/bki-transportation/](https://prezi.com/nker_pzc8v0k/bki-transportation/)

<sup>2</sup> [Energy Independence Now](https://einow.org/) <https://einow.org/>

request because fuel is a different budget than acquisition. Although fleets remain an important buying audience, automakers are targeting end consumers.

To continue the deployment in hydrogen stations, the document is intended to provide recommendations and best practices for developing regional hydrogen readiness plans. The goal is to increase the number of fuel cell electric vehicles in California by leveraging experience from one city to the next to develop a strong network of stations.

# CHAPTER 2:

## Hydrogen Readiness

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### Overview

The main components of the Hydrogen Readiness in Early Market Communities are the Regional Readiness Plan based on research and stakeholder input and education and outreach to targeted audiences: fleet managers, station developers, and fire personnel.

Deployment of retail hydrogen stations and commercial fuel cell FCEVs began in late 2015.

The *2016 Annual Evaluation of Hydrogen Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development* ARB, July 2016) noted, "By the end of 2016, ARB projects 38 stations will be open and all 50 currently funded stations, including upgrades for many non-retail stations, are projected to be complete by the end of 2017. This is in keeping with the strategy to ensure hydrogen fueling stations are in place and open in advance of broader FCEV rollout."<sup>3</sup> The report also stated that 331 FCEVs are currently registered with the Department of Motor Vehicles.

Accelerating the pace of hydrogen station development and the acceptance of FCEVs into local ZEV plans will require a regional approach in which municipalities share experience, knowledge and resources. Bringing more renewable hydrogen into the statewide network will require widespread support for centralized biogas production of hydrogen, including looking at incentives that currently only apply to electricity or biofuel production.

### Training and Outreach

Throughout the project, BKi Transportation and SCAQMD conducted:

- Conducted four stakeholder meetings related to planning and permitting hydrogen stations
- Conducted two outreach events and planned a third targeting owners and operators of retail gas stations and the supply chain
- Conducted a webinar about new fire codes
- Attended two conferences targeting first responders to provide information about FCEVs
- Conducted two first responder trainings with the HAMMER flame prop
- Conducted three meetings about data needs for hydrogen stations and the Station Operational Status System (SOSS)
- Presented findings of the market research study at three industry meetings

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<sup>3</sup> [California Resource Board](https://www2.arb.ca.gov/) <https://www2.arb.ca.gov/>

# CHAPTER 3:

## Hydrogen Readiness in Early Market Communities Activities and Data Collection

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### Potential Policy Proposals, Incentives, and Financing Options

In its report, *Crediting Hydrogen: An assessment of fuel incentives and renewable hydrogen investment in California*, Energy Independence Now proposed four broad approaches to help start this process.

- Seek new funding for renewable hydrogen supply to complement network development funds. Focusing on the supply of renewable hydrogen, rather than depending on the demand for it by retail stations, could drive investment more directly. Possible mechanisms include increasing direct support for biogas or electrolysis facilities and ensuring that Low Carbon Fuel Standard credits are offered to the hydrogen network first. The AB2 Greenhouse Gas Reduction Fund<sup>4</sup> is conceptually well aligned to support this kind of effort.
- Explore new funding and mechanisms to offset the renewable hydrogen cost. In all but the most recent Energy Commission hydrogen station solicitations, 100 percent renewable hydrogen projects were able to apply for a separate “carve-out” within the solicitation. Some stakeholders have suggested that this adds a layer of complexity to an already difficult balancing act of choosing between appropriate coverage vs. capacity stations. The Energy Commission could solicit input on alternative ways to promote renewables. One option would be to offer a fixed, incremental payment for stations that are already approved using the normal metrics but that exceed the 33 percent renewable hydrogen requirements. Payments could be linked to total capacity and percentage of renewable feedstock. This would in effect “decouple” the goal of choosing the best station for the network from the goal of promoting renewable hydrogen. This or any similar mechanism aimed at buying down the cost of the renewable target is worthy of support from funding sources such as the AB2 Greenhouse Gas Reduction Fund.
- Target utilities and the California Public Utilities Commission to raise hydrogen- related issues. From a utility perspective, hydrogen stations and centralized production facilities offer opportunities for concentrated load growth, demand-side management, and grid ancillary services. California Public Utilities Commission and utility-related policies and incentives that need to be reviewed and adjusted to allow utilities to successfully promote the use of hydrogen include rate plans for electrolyzers, definitions of energy storage, integration into renewables planning, grid planning implications, and payments for grid ancillary services. These policies also relate to whether utilities could count hydrogen production based on stranded renewables toward meeting their own renewable portfolio standard targets.

Support Renewable Gas Credits. Renewable Electricity Credits<sup>5</sup> have played an instrumental role in decoupling the physical generation of renewable power from the investor, while

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<sup>4</sup> [California Legislator website](http://leginfo.legislature.ca.gov) <http://leginfo.legislature.ca.gov>

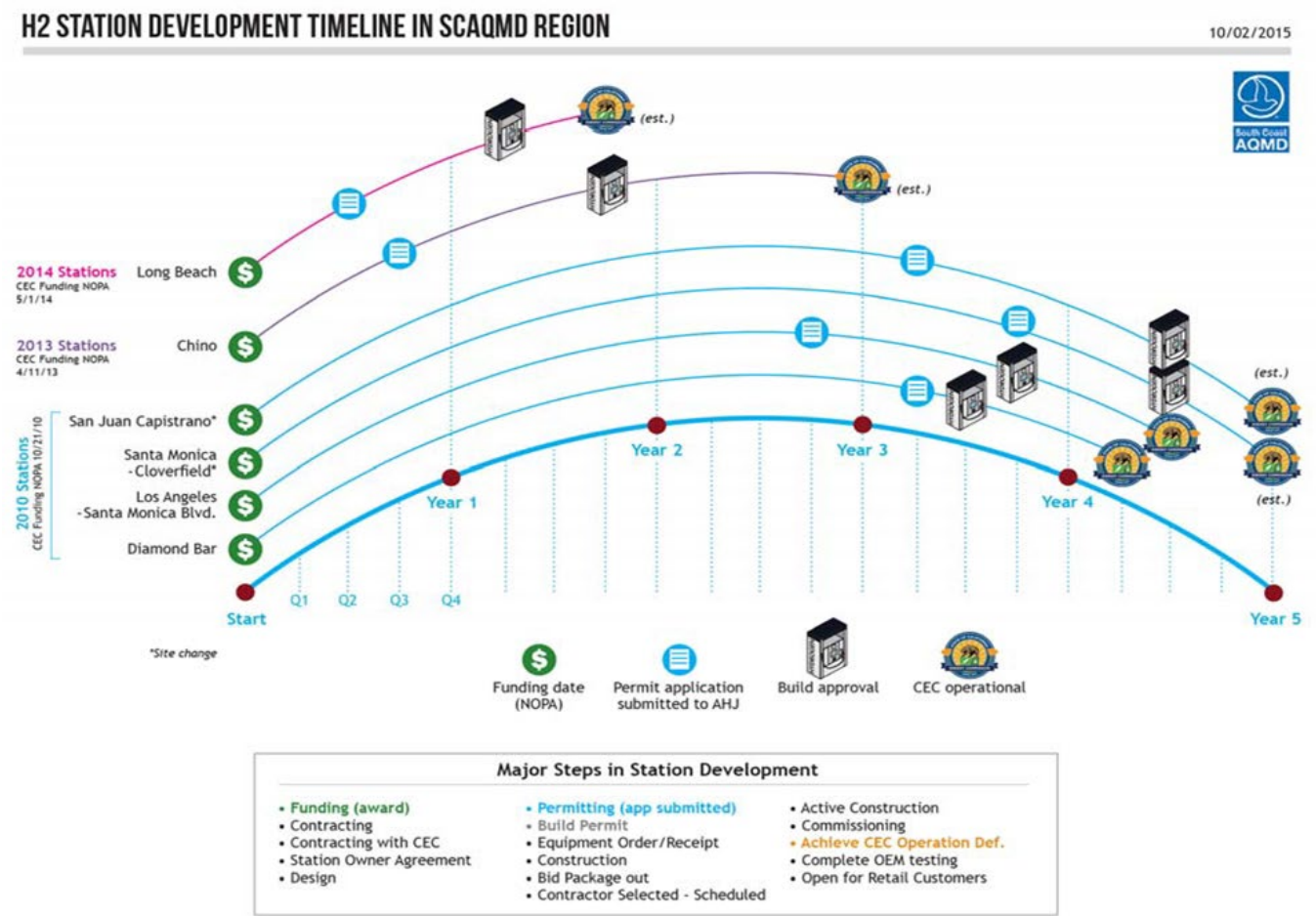
<sup>5</sup> [Access to the Full Report](https://einow.org/) <https://einow.org/>

ensuring there is no double counting of that power. If centralized biogas production is to play a key role in the hydrogen sector, enabling hydrogen to meet its renewable targets, an equivalent formal biogas “credit” system will be necessary. Hydrogen advocates should support efforts to develop such credits.

## Challenges and Best Practices

- BKi assessed the time to plan, permit, deploy, maintain, and inspect hydrogen infrastructure in the SCAQMD region according to development phases used by the Governor’s Office of Business Development (GO-Biz). Results over time are displayed in Figure 1.

Figure 1: Hydrogen Station Development Timeline



Source: GO-Biz

- BKi identified that station developers were the stakeholders most needed to reduce the time to plan and permit a hydrogen station. We conducted as shown in Table 1 below.



**Table 1: Stakeholder Meetings**

Meeting date	Type of meeting	Purpose
April 21, 2015	Initial Station Developer/Operator Group (SD/SO) Meeting <i>Shell Hydrogen Station 2051 W. 190th St. Torrance, CA 90501</i>	Identification of key issues/challenges for Hydrogen Station Developers and Operators
May 8, 2015	SD/SO Group Conference Call	Discuss pre-permitting meetings
June 17, 2015	SD/SO Group Conference Call	Hydrogen Station Validation Process Checklist
June 25, 2015	SD/SO & OEM Joint Meeting: Station Commissioning Workshop <i>Northern California Center for Alternative Transportation Center 3300 Industrial Blvd. Suite 1000 West Sacramento, CA 95691</i>	H2 Station Confirmation/Commissioning workshop meeting notes

Source: BKi

- Exhibited at the Western Petroleum Marketing Association Conference on February 15- 18, 2016 with Dwight Zuck of Air Liquide. Provided draft outreach materials developed in December and hands-on experience with a hydrogen dispenser mock-up. Reached approximately 70 people.

**Figure 2: Western Petroleum Marketing Association Conference**



Source: Western Petroleum Marketing Association

- Conducted a tour of the First Element station in South San Francisco for the Fuels Institute meeting on April 27 for 50 people representing 38 companies. Fuels Institute connects stakeholders from across the fuels and vehicles industries to share ideas and explore



opportunities for a path to a successful future. It has been very supportive of hydrogen and instrumental in providing information to a diverse group of people within the gasoline and compressed natural gas industry. The station tour is shown in Figure 3 below.

**Figure 3: Fuels Institute Tour of South San Francisco Station**



Source: BKi

- Planning for the fall Pacific Oil Conference where we will display a Mirai and the Air Liquide mock-up dispenser. (Attending the conference is outside the time frame of this contract.)
- Updated the interactive website for hydrogen infrastructure planning and permitting guidelines and templates to include [recent and relevant information and permitting templates](https://h2tools.org/) at <https://h2tools.org/>. A screen shot of the front page is below in Figure 4.

**Figure 4: Hydrogen Readiness website**



Source: BKi

- The California Fire Code and California Building Code were amended to achieve this adoption and “[Early use of National Fire Prevention Association \(NFPA\) 2 and the amendments may be accomplished on a case-by-case basis in accordance with the alternate means and methods of construction provisions contained in California Fire Code or California Building Code Section 1.11.2.4.](#)” Please see <https://osfm.fire.ca.gov/>
- Conducted a webinar with NFPA about the 2016 edition of NFPA 2 on May 31 for 79 participants primarily representing city governments. The presentations are included at the end of this report.

## Training

- Participated in Firehouse World in San Diego on January 31-February 2, 2016 with a Toyota Mirai, mock-up hydrogen dispenser and safety equipment displayed on the exhibit floor. Firehouse World is a comprehensive conference serving U.S. fire-service leadership with the education, products and technologies. Most of the 700 attendees are captains, chiefs, fire fighters and training officers. BKi provided information and education to a variety of firefighters in English and in Spanish. Figure 5 is a tweet from the meeting.

**Figure 5: Tweet in Spanish from Firehouse World**



Source: BKI

- Disseminated the Guide to Permitting Hydrogen Motor Fuel Dispensing Facilities developed by the National Renewable Energy Laboratory that provides information about codes and standards that could help the design and construction, and regulatory approval of hydrogen dispensing stations.<sup>6</sup>
- Conducted training with the Kidde Flame Prop in conjunction with HAMMER/Handford Fire<sup>7</sup> at Continuing Challenge, in September 2015. The class reached 17 people that represented fire departments, emergency services, California Department of Transportation, and California Highway Patrol. Training included an in-class presentation and hands-on exercises with a live fire flame prop for hydrogen and propane. Additionally, hundreds of fire chiefs and captains were exposed to the Toyota Mirai that was on display for the three-day event. Figures 6 through 9 are photos from Continuing Challenge.

<sup>6</sup> [National Renewable Energy Laboratory](https://www.nrel.gov) <https://www.nrel.gov>

<sup>7</sup> [Hanford Fire Department Ca](https://www.facebook.com/HanfordFire) <https://www.facebook.com/HanfordFire>

**Figure 6: Attaching hydrogen to the flame prop**



Source: BKi

**Figure 7: Trainers soak the parking lot to keep debris from burning**



Source: BKi

**Figure 8: Trainees listen for the sound of escaping hydrogen and learn to identify a hydrogen flame**



Source: BKi

**Figure 9: First responders learn about FCEVs and hydrogen at the static display**



Source: BKi

- Attended Fire Shows West in Reno, NV in October 2015. The conference draws hundreds of active duty firefighters from California and other west coast states for National Fire Academy training. BKi provided a classroom education session and hands-on experience with the Toyota Mirai.
- Conducted training with Hanford Fire using the HAMMER Flame Prop for the City of Riverside Fire Department in conjunction with the hydrogen station scheduled to open in late Quarter 3 to early Quarter 4 2016. The sessions were two hours each, four sessions a day for three consecutive days. This schedule necessary to reach the maximum number of firefighters in all three shifts (A, B, C). We reach 145 fire fighters, including captains and training officers. Figures 10-13 are pictures from the Riverside Fire Training Center.

**Figure 10: Flame prop at the Riverside Fire Training Center**



Source: BKi

**Figure 11: Battalion Chief James Bryan of Hanford Fire pointing out considerations for responding to the vehicle during an incident with a Hyundai Tucson**



Source: BKi

**Figure 12: Chief Bryan demonstrates the low radiant heat of the hydrant flames**



Source: BKi



**Figure 13: A City of Riverside FD firefighter preparing the safety hose line for a fire prop demonstration.**



Source: BKi

A recommendation from Task 4 is to have California fire officials certified by Kidde to train with the prop to increase ability to use it in regional training. Currently, only two members of the Hanford fire department are certified. (Hanford is the fire department at the HAMMER training facility in Washington.)

## **Procurement Best Practices**

- BKi obtained a database of public and private fleet operators and used the database to provide information about upcoming events, the survey conducted in Task 6, provide materials developed in Task 6, and to promote the Department of General Services template language.
- The Department of General Services created procurement language for FCEVs under the State's ZEV Action Plan in the intervening time between the notice of proposed adjustment and contract. BKi has disseminated the template language via email and at a National Association of Fleet Managers meeting in on July 22, 2015. The language is included at the end of this report.
- Provided support to the GO-Biz to develop, write, and perform graphic design and page layout for the [Hydrogen Station Permitting Guidebook](https://business.ca.gov/about/about-go-biz/) available at <https://business.ca.gov/about/about-go-biz/>

## **Report on Fuel Station Monitoring Systems**

The availability of fuel is a common concern among fleet operators and individual drivers considering a FCEV purchase. All California retail hydrogen stations use a simple web and mobile application called SOSS that provides online/offline information about participating

hydrogen stations so that drivers know fuel is available before travelling to the station. Other entities, including the National Renewable Energy Lab (NREL) and UC Davis use SOSS data in other applications. SOSS is an open-source application that is provided for free to all hydrogen station operators.

The purpose of this project was to investigate and understand how monitoring systems at gasoline stations and electric charging stations work and identify best practices that will inform future development of SOSS. Table 2 compares functionality of all three systems.

**Table 2: Comparison of Functionality of Management Software for Gasoline, Charging, and Hydrogen Stations**

<b>Feature/Function</b>	<b>Gasoline</b>	<b>Charging</b>	<b>Hydrogen</b>
Connected to a network	Yes	Some	Yes
Type of network	Wireless LAN	High-speed	2G cellular
Accepts payment	Yes	Some	Yes
On-site payment gateway	Yes	No	Yes, retail stations
Location mapping	Yes, one predominates system with user-generated content (GasBuddy)	Yes, multiple systems with automated and user-generated content (PlugShare <sup>8</sup> and proprietary)	Yes, one system with automated content SOSS
Station availability (end user)	User-generated (GasBuddy)	For some networked stations (Proprietary)	Automated SOSS
Station availability (operator)	Yes (Proprietary)	For networked stations (Proprietary)	Yes (Proprietary)
Station diagnostics and troubleshooting	Depends on software system (Proprietary)	For networked stations (Proprietary)	Yes (Proprietary)

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<sup>8</sup> [PlugShare](https://www.plugshare.com/) <https://www.plugshare.com/>



<b>Feature/Function</b>	<b>Gasoline</b>	<b>Charging</b>	<b>Hydrogen</b>
Remote reboot/restart	Depends on software system (Proprietary)	For networked stations (Proprietary)	Yes (Proprietary)
Data collection and reporting to third-parties	Payment data for taxes  Operators can voluntarily report supply and sales data	Operators and EVSE providers can voluntarily report data for networked stations	Operators report data via forms to funding agencies and research labs

Source: BKi

## **SOSS Data Needs**

BKi met with station developers, automakers, and NREL to determine the following SOSS data needs:

- Station naming conventions that are more customer friendly. For example, the station known to stakeholders as “Tahoe” is actually in Truckee, California.
- A method of indicating that a station has recently opened and is in “shake-down” period. This developed into a soft-opening process that is being refined at the writing of this report.
- A process to communicate planned station outages or stations that are unavailable for more than 24 hours. For example, at the writing of this report, the Santa Monica station is closed due to construction at the gas station portion and SOSS needed to provide this information to customers and stakeholders.
- Real-time updates instead of every 15 minutes
- A method to track and report station reliability
- Fields to collect hydrogen price, customer comments, and percentage of renewable hydrogen

The last three items in the list should be considered in future upgrades to the system. Key recommendations for Task 5 are:

- Continue to dissect the Department of General Services procurement language to fleets.
- Understand the data the Energy Commission and Department of Energy require for stations they funded, and if the station developers are meeting their reporting obligations. If so, explore the best way to share that information with other stakeholders.
- Determine if public and private funders need additional data to make investment decisions (e.g. station locations, cost reduction) and the best way to collect and share that data.
- As SOSS is upgraded, provide a funding pool for station developers to make software updates, including the option to use Energy Commission operating and maintenance grant funding.
- Conduct a technical evaluation of SOSS and of hydrogen station software to determine:
- Specific data elements that are internet protocol or could be compromised by sharing data.

- An upgrade path for SOSS to incorporate more data and different types of data.
- If SOSS can be incorporated into existing back-end management systems, or if it should continue as a stand-alone system.
- Build out the user-facing aspect of SOSS, including fields for price and user comments.

## **Market Analysis, Education and Outreach**

### **Conduct market research and survey consumers about the adoption of Alternative Fuel Vehicles and FCEVs**

- BKi conducted market research with:
  - An online survey
  - Two focus groups
  - Individual one-on-one interviews
- During research, BKi took initiative to remedy some of the gaps in available materials about FCEVs, including:
  - Contacting the staff at the United States Environmental Protection Agency Office of Transportation and Air Quality who run the SmartWay program and produce the Fuel Economy Guide with a request to include FCEVs in the two buyer's guides. The United States Environmental Protection Agency stated that "fuel cell vehicles are a new and emerging technology, which is still largely in the development process."
  - [Contacted Oakridge National Labs](https://fueleconomy.gov), the group that administers <https://fueleconomy.gov>, with suggestions to update information, including broken links and references to fact sheets that were written more than 10 years ago. We also initiated a process to change the "Benefits & Challenges" section to "New & Coming," which is a menu listing used by all other alternative fuel's websites research project.
  - Contacted the Air Resources Board's Clean Cars programs with updated links to FCEV information on the DriveClean website<sup>9</sup> and a request to include the California Fuel Cell Partnership station map.
  - Requested H2USA<sup>10</sup> work with the Energy Information Agency to update its web pages about hydrogen fuel and fueling.
  - Delivered draft and final reports to the Energy Commission for review and public dissemination.

### **Develop and Disseminate Outreach Materials**

- BKi presented a summary of results at the December 2015 California Fuel Cell Partnership (CaFCP) working group meeting for initial feedback. The automakers present at the meeting did not disagree with the information and seemed anxious to review the report once it's approved by SCAQMD and the Energy Commission.

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<sup>9</sup> [DriveClean](https://driveclean.ca.gov/) <https://driveclean.ca.gov/>

<sup>10</sup> [H2USA Website](https://www.h2usa.org/) <https://www.h2usa.org/>

- BKi presented a summary of results at the February 2016 meeting of the Plug-in Electric Vehicle Collaborative and at a Northeast States for Coordinated Air Use Management<sup>11</sup> meeting at the New York Auto Show. The presentation is included at the end of this report.
- Presentations led to other discussions about the effect of incentives in an early market and about message development for a statewide or nationwide ZEV awareness campaign. It appears that initial campaigns will be focused on plug-in vehicles only.

## **Hydrogen Retail Fuel Study**

This paper examines the research and drivers that shaped the development and evolution of hydrogen station features and placement during planning and early market introduction of FCEVs in California. It is intended to help businesses, communities, and regions understand the evolution of hydrogen station siting to avoid planning and proposing station locations that do not meet the evolving standard for hydrogen. This includes locations that provide:

- Lighting
- Unobstructed ingress/egress to the fueling facility
- Directional signage to the nearest thoroughfare
- Maximized hours of operation
- Staffing by a fueling station attendant
- Inclusive use of a self-serve, menu-driven dispenser that does not require PPE
- Customer experience for fueling comparable to other fueling stations
- Unrestricted access without a requirement of an access card or PIN code, OEM/customer liability agreements, and formal/registered station training of each individual consumer
- A POS terminal that accepts major credit cards, debit cards, and fleet card payment systems like those commonly used at gas stations.
- Delivered draft and final reports to the Energy Commission for review and public dissemination.

## **Regional Plan for Hydrogen as a Transportation Fuel**

- Created a 40-page Best Practices and Recommendations document that cities, counties, and regional groups can use to plan for hydrogen station and FCEV deployment. The plan provides background information and specific action items that cover:
- Best practices and recommendations for planning, permitting, and deployment of hydrogen stations
- Best practices and recommendations for training first responders and fire officials
- Best practices and recommendations for increasing the procurement and commercialization of hydrogen stations
- Best practices and recommendations for local and regional groups to communicate the benefits of ZEVs in general and FCEVs in particular.
- Best practices and recommendations to assist traditional fuel retailers to increase the availability of hydrogen stations.
- Existing and potential incentives for renewable hydrogen.

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<sup>11</sup> [Northeast States for Coordinated Air Use Management Website](http://www.nescaum.org/) <http://www.nescaum.org/>

- The document will be distributed at the League of California Cities meeting, the Northern California Clean Technology Forum, and through the Northern California Center for Alternative Transportation.

## CHAPTER 4:

# Summary of Recommendations

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Key recommendations include:

- Make hydrogen from renewable sources eligible for credits under California’s Low Carbon Fuel Standard. This will create an additional revenue stream to help producers cover costs.
- The average time to permit and build a hydrogen station has decreased significantly but is not yet on par with permitting and building a gasoline station. Strong regional partnerships are essential for continued improvement in this area.
- All stakeholders need succinct messaging about the benefits of adding hydrogen to an existing fueling station and realistic information about the number of cars the stations will fuel in Year One through Year Five.
- For fire and safety training, train-the-trainer courses are vital for reaching all firefighters.
- Targeted messaging to ZEV buyers and fleet buyers will encourage increased adoption of FCEVs, and a wide-reaching awareness campaign will help other audiences select FCEVs for their future car purchase.
- Government and industry participation in stakeholder organizations is crucial to reducing station costs and bringing more renewable hydrogen into the fuel supply.
- Tables 3-9 below are summaries of the above information.

**Table 3: Summary of potential policy proposals, incentives, and financing options**

Topic	Recommendation	Lead
Incentivizing Renewable Hydrogen	Make hydrogen from renewable sources eligible for credits under California’s Low Carbon Fuel Standard	ARB
	Consider centralized production and distribution of renewable hydrogen in all future planning efforts for the hydrogen infrastructure	Government funders

Source: BKi

**Table 4: Summary of challenges and best practices**

Topic	Recommendation	Lead
Planning, Permitting, and Deploying Hydrogen Stations	Start outreach to community leaders, including city employees, business owners, and residents when a station is in the planning phases. Tailor outreach for every community, and leverage experience from cities’ experience with compressed natural gas, electric charging, or nearby cities’ hydrogen stations.	Station developers, city leaders, Clean Cities Coordinators, station funders

<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
Planning, Permitting, and Deploying Hydrogen Stations	Pre-permitting meetings between the station developer, local AHJs, and an objective third party were effective at facilitating the permitting process; however, this level of effort is not sustainable for State government. Leverage people who have been through the process at one city to be the objective intermediary party for the region.	AHJs in cities and regions
	Clear agreements between the station developer and the owner of the host site are vital for reducing the timeline and should be enacted early in the process. Local government can play a role by helping ensure the owners of record are signing contracts.	Station developers, AHJs in cities and regions
	Use the Hydrogen Station Permitting Guidebook during the planning and permitting processes.	Station developers, AHJs in cities and regions
	Factor in the time for commissioning when estimating station open dates so that customer expectations are not disappointed.	Station developers AHJs in cities and regions Local businesses
	Update the Hydrogen Station Permitting Guidebook annually to incorporate new codes and standards, technology changes, and lessons learned. Expand the content to include the commissioning process.	GO - Biz or a delegate
Codes and Standards	Adopt NFPA 2 into local fire code before the State of California code cycle is complete. maintenance facilities and parking garages.	AHJs in cities and regions
	Identify gaps in codes and standards for repair and maintenance facilities and parking garages.	AHJs in cities and regions Industry Stakeholders
	Integrate information about repair and maintenance facilities and parking garages into the Hydrogen Station Permitting Guidebook.	GO - Biz or a delegate

Source: BKi

**Table 5: Training**

<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
Fire and Safety Training	Work early and often with the fire department to get onto their training schedule because calendars fill quickly.	Local fire departments NFPA, CaFCP, and training organizations
	Train-the-trainer courses are vital for reaching all firefighters. Each fire station has three shifts, and people often change position. The only way to consistently reach most personnel is for the trainers to include information in their classes.	Local fire departments NFPA, CaFCP, and other training organizations
	Understand each department's individual training needs. Some prefer classroom training; others prefer hands-on training.	Local fire departments NFPA, CaFCP, and other training organizations
	When using the prop, make the training as regional as possible to reach the widest audience. Instead of one class for a fire department, arrange a week of instruction at a regional training center with several classes per day.	Clean Cities Coordinators Office of the State Fire Marshal Local fire departments Counties NFPA, CaFCP, and other training organizations
	Currently, only two people are trained to operate the flame prop. More personnel need to be trained by Kidde on its operation so that the unit can be more widely used. Ideally, trainers will be from local fire training academies instead of from DOT's Hanford Fire/HAMMER program.	Kidde HAMMER Office of the State Fire Marshal Fire academies

Source: BKi

**Table 6: Procurement Best Practices**

<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
Fleet procurement	Refer to the Department of General Services Management Memo MM13-04 for template language and calculations for including FCEVs in ZEV purchases.	Municipal and private fleet operators
	Provide a resource (person) for fleet managers who can help identify funding sources, incentives that apply to fleets, and can help answer questions about FCEV benefits.	GO-Biz Clean Cities Coordinators
	Conduct ride and drives and outreach events aimed at fleet drivers with the intention of better educating fleet drivers about the vehicles.	Local or regional governments Metropolitan Planning Associations (AMPOs) Clean Cities Coordinators
	Include the free fuel provided with FCEVs into the overall cost of ownership of the vehicle to provide a more realistic picture of the final ownership and operating costs.	Local or regional governments Fleet managers
	Provide updated and accurate information about FCEVs on FuelEconomy.gov and DriveClean.ca.gov. Currently, both sites list FCEVs as vehicles that are not commercially available.	United States Environmental Protection Agency California Air Resources Board
	Provide a Fuel Cell Electric Vehicle Resource Center, similar to the Plug-in Vehicle Resource Center, on the DriveClean website.	California Air Resources Board
	Use the <a href="http://www.cafcp.org/stationmap">hydrogen station map</a> at <a href="http://www.cafcp.org/stationmap">www.cafcp.org/stationmap</a> to understand the availability of hydrogen fuel.	Fleet managers
	When evaluating ZEVs, consider the cost of an installing and maintaining a	Fleet managers Local or regional governments



<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
	networked charging station compared to using a public hydrogen station.	
Increase the Availability of Hydrogen Stations	Create partnerships between the local community, hydrogen station developers, and gas station owners.	AMPOs Local or regional governments California Fuel Cell Partnership California Hydrogen Business Council
	Conduct tours of existing hydrogen stations with stakeholders interested in building stations to address questions about safety, codes and standards, equipment, technology, and business opportunities	AMPOs Local or regional governments California Fuel Cell Partnership California Hydrogen Business Council
	Position local efforts as part of a bigger picture that includes national and international development, transit activities, and medium- and heavy-duty vehicles.	AMPOs Local or regional governments California Fuel Cell Partnership California Hydrogen Business Council
	Share fleet procurement plans (1-5 years) with gas station owners to help them understand how a dedicated fleet might build.	Local or regional governments Fleet managers
	Engage commercial real estate agents to help establish relationships with the fuel retailer community and also to identify potential hydrogen station sites	Local or regional governments

Source: BKi

**Table 7: Market Analysis, Education, and Outreach**

<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
	Focus on “awareness” campaigns targeted to consumers, fleet managers, and fleet drivers to introduce FCEVs.	AMPOs Local or regional governments California Fuel Cell Partnership California Hydrogen Business Council
	Simplify the number of steps from the DMV website to the DriveClean website. Include action request (e.g. visit the manufacturer’s website, take a test drive) on DriveClean	Division of Motor Vehicles Air Resources Board
	Update and make consistent the information about HOV access stickers so that potential drivers have the same information on every site	Division of Motor Vehicles Air Resources Board Alternative Fuel Data Center United States Department of Energy (U.S. DOE) United States Environmental Protection Agency
	Increase awareness about the state, federal, and local rebates and tax credits for FCEVs.	AMPOs Local or regional governments Air Districts State agencies (ARB, DMV) CaFCP California Hydrogen Business Council

Source: BKi

**Table 8: Conduct Market Research**

<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
	Focus on “awareness” campaigns targeted to consumers, fleet managers, and fleet drivers to introduce FCEVs.	AMPOs Local or regional governments California Fuel Cell Partnership California Hydrogen Business Council
	Simplify the number of steps from the DMV website to the DriveClean website. Include action request (e.g. visit the	Division of Motor Vehicles Air Resources Board

<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
	manufacturer's website, take a test drive) on DriveClean	
	Update and make consistent the information about HOV access stickers so that potential drivers have the same information on every site	Division of Motor Vehicles Air Resources Board Alternative Fuel Data Center U.S. DOE FuelEconomy.gov United States Environmental Protection Agency
	Increase awareness about the state, federal, and local rebates and tax credits for FCEVs.	AMPOs Local or regional governments Air Districts State agencies (ARB, DMV) CaFCP California Hydrogen Business Council
	Make well-to-wheels GHG and pollution emissions data available on DriveClean.	Air Resources Board
	Create a cost calculator that balances lease vs. buy and includes the rebate and fuel allowance. Tailor it by region to include local incentives and perks, such as free parking in municipal lots.	State agencies (ARB, DMV, CEC) AMPOs Local or regional governments Air Districts
	Consider a pilot program that creates a pool of money that new car dealers can use to provide their own targeted incentives, such as customer incentives (cash-back rebate, lower loan interest, reduced vehicle cost), or an employee incentive (additional commission), or local advertising. Study how local incentives can impact the uptake of ZEVs in general and FCEVs in particular.	State agencies (ARB, CEC) AMPOs Local or regional governments Air Districts

Source: BKi

**Table 9: Outreach Materials**

<b>Topic</b>	<b>Recommendation</b>	<b>Lead</b>
	Position California's hydrogen refueling development within a global perspective; show how the state's progress contributes to a worldwide effort.	State agencies (ARB, CEC) AMPOs Local or regional governments Air Districts California Fuel Cell Partnership California Hydrogen Business Council
	Station owners need succinct messaging about the benefits of adding a hydrogen station and realistic information about the number of cars they can expect to fuel.	All stakeholders
	Provide directional signage for hydrogen stations	California Department of Transportation Local or regional governments
	Provide reserved parking for FCEVs, similar to parking for carpool vehicles, at municipal lots, shopping malls, sports venues, and similar	Local or regional governments
	Include FCEVs in local electric vehicle events, alternative transportation or energy events, Earth Day activities, and similar	AMPOs Local or regional governments Air Districts Businesses
	Use the H2tools portal for hydrogen safety training materials. <sup>12</sup>	Local AHJs Fire departments Fire training academies
	Incorporate the Station Operational Status System on a wider scale, including its potential use in other fuel stations (natural gas, electric charging).	Station developers U.S. DOE NREL Energy Commission
	Incorporate SOSS data into local geographic information	Local or regional governments

<sup>12</sup> [H2Tools](https://h2tools.org/) <https://h2tools.org/>

Topic	Recommendation	Lead
	systems, or make available to real estate agents to attract residents who want to live or work near a hydrogen station	AMPOs

Source: BKi

# GLOSSARY

**AIR RESOURCE BOARD (ASB)**—CARB is charged with protecting the public from the harmful effects of air pollution and developing programs and actions to fight climate change. From requirements for clean cars and fuels to adopting innovative solutions to reduce greenhouse gas emissions, California has pioneered a range of effective approaches that have set the standard for effective air and climate programs for the nation, and the world

**ALTERNATING CURRENT (AC)**—Flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.

**BATTERY ELECTRIC VEHICLE (BEV)**—Also known as an “All-electric” vehicle (AEV), BEVs utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source in order to recharge.

**CALIFORNIA DEPARTMENT OF TRANSPORTATION (Caltrans)**—Responsible for the design, construction, maintenance, and operation of the California State Highway System, as well as that portion of the Interstate Highway System within the state's boundaries.<sup>13</sup>

**CALIFORNIA ENERGY COMMISSION (CEC)**—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's five major areas of responsibilities are:

1. Forecasting future statewide energy needs
2. Licensing power plants sufficient to meet those needs
3. Promoting energy conservation and efficiency measures
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels
5. Planning for and directing state response to energy emergencies.

**CALIFORNIA FUEL CELL PARTNERSHIP (CaFCP)**—The California Fuel Cell Partnership is an industry/government collaboration aimed at expanding the market for fuel cell electric vehicles powered by hydrogen to help create a cleaner, more energy-diverse future with no-compromises to zero emission vehicles.

**COMPRESSED NATURAL GAS (CNG)**—Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

**DEPARTMENT OF MOTOR VEHICLES (DMV)**—The California Vehicle Act of 1914 created laws governing all things related to driving and vehicles. Year by year, new laws were created, and

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<sup>13</sup> [Department of Transportation glossary webpage](https://dot.ca.gov/az.html) <https://dot.ca.gov/az.html>

existing laws were amended to manage the growing number of vehicles hitting California roads each year.

**DIRECT CURRENT (DC)**—A charge of electricity that flows in one direction and is the type of power that comes from a battery.

**FUEL CELL ELECTRIC VEHICLE (FCEV)**—A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.

**GOVERNOR'S OFFICE OF BUSINESS AND ECONOMIC DEVELOPMENT (GO-Biz)**—Serves as the State of California's leader for job growth and economic development efforts. They offer a range of services to business owners including attraction, retention and expansion services, site selection, permit assistance, regulatory guidance, small business assistance, international trade development, and assistance with state government.

**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)**—A global self-funded nonprofit organization, established in 1896, devoted to eliminating death, injury, property, and economic loss due to fire, electrical, and related hazards.

**NATIONAL RENEWABLE ENERGY LABORATORY (NREL)**—The United States' primary laboratory for renewable energy and energy efficiency research and development. NREL is the only Federal laboratory dedicated to the research, development, commercialization, and deployment of renewable energy and energy efficiency technologies. Located in Golden, Colorado.<sup>14</sup>

**STATION OPERATIONAL STATUS SYSTEM (SOSS)**—includes a database and simple mobile web app that is provided free to every hydrogen station in North America. Each hydrogen station is listed in a database entry with static information: location, opening hours, contact information, etc.<sup>15</sup>

**SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)**—The air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties. This area of 10,740 square miles is home to over 17 million people—about half the population of the whole state of California. It is the second most populated urban area in the United States and one of the smoggiest. Its mission is to clean the air and protect the health of all residents in the South Coast Air District through practical and innovative strategies.

**UNITED STATES DEPARTMENT OF ENERGY (U.S. DOE)**—The federal department established by the Department of Energy Organization Act to consolidate the major federal energy functions into one cabinet-level department that would formulate a comprehensive, balanced national energy policy. DOE's main headquarters are in Washington, D.C.

**ZERO EMISSION VEHICLE (ZEV)**—Vehicles that produce no emissions from the on-board source of power (e.g., an electric vehicle)

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<sup>14</sup> [National Renewable Energy Laboratory](https://www.nrel.gov) <https://www.nrel.gov>

<sup>15</sup> [Station Operational Status System Document](https://frontierenergy.com/wp-content/uploads/Station-Operational-Status-System-case-study.pdf) <https://frontierenergy.com/wp-content/uploads/Station-Operational-Status-System-case-study.pdf>